

underestimated if significant undetected emigration occurs. Emigration is probably most problematic with respect to juvenile survival estimates because juveniles disperse considerable distances from their natal sites. It is also likely that some emigration of adults and subadults occurs as well. To better understand population trends of spotted owls, we need more years of data and we need to develop methods to test the magnitude of possible biases in mark-recapture estimates. One way to determine the extent of undetected emigration is to compare survival estimates from radio-marked and color-banded samples. This will be very expensive and time-consuming as it will involve radio-marking large samples of owls.

DENSITY OF NORTHERN SPOTTED OWLS

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Density is a useful measure for estimating population size, monitoring spatial and temporal population trends, and examining mechanisms of population regulation. We examined density estimates for northern spotted owls from 10 study areas on public lands distributed throughout northern California, Oregon and Washington. Density was estimated based on banded individuals on these study areas which ranged from 300 to 1000 km² in size. Densities on individual study areas were measured over periods ranging from 2 to 8 years. Crude density (number of owls/km² of total area) ranged from 0.067 to 0.250 owls/km². We tested hypotheses concerning temporal and spatial trends in density estimates. Trends in density appeared stable while there appeared to be geographic differences. We also evaluated density estimates from public lands with those from private lands managed for timber production. We discuss the problems inherent in accurately estimating density and the utility of density in monitoring programs. We also discuss considerations for estimating density such as sampling design, study area size, and survey effort.

MANAGEMENT ACTIVITIES ON PRIVATE TIMBERLANDS AND INDUSTRY-SUPPORTED RESEARCH ON NORTHERN SPOTTED OWLS

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Private timberlands owners in the Pacific Northwest and northern California have developed various approaches to managing their lands relative to legal obligations and voluntary contributions for protecting the northern spotted owl as a federally listed threatened species. Such activities depend upon the size and continuity of the private forests as well as the owner's objectives. Many private owners

contract for annual surveys to locate owls, and some companies evaluate nest-site conditions and monitor reproduction success on their lands. Such activities may be used to schedule timber harvests to avoid locations with owls, or they may support development of habitat conservation plans, or HCPs. For example, one company in northern California (Simpson) recently had an HCP approved by the Fish and Wildlife Service for operations on their lands. Another company maintains a computerized database of the status of all owls on their lands or on adjacent lands that may affect their operations. The same company is developing a GIS-based process for predicting other owl locations based upon conditions of known sites in managed forests. In many other cases, private companies survey their lands to determine if planned timber operations do not contain spotted owls. Several private companies support research on their lands to learn more about owl habitat requirements, and some have implemented case-history experiments with innovative forestry practices or special techniques (e.g., nest boxes) that may accommodate owls. In addition, a consortium of companies that purchase federal timber support cooperative research on owl populations and habitat relationships. The goal of much of the industry-supported research is to develop new technology that may support forest management alternatives that account for habitat needs of the owl while minimizing costs to wood production. Examples of topics that are being investigated in cooperation with federal agencies will be presented.

PREDATORS, COMPETITORS, AND MOBSTERS: INTERSPECIFIC INTERACTIONS INVOLVING NORTHERN SPOTTED OWLS

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Interactions between spotted owls and other wildlife species can be placed into four main groups: prey, predators, competitors, and species which are involved in mobbing behaviors ("mobsters"). This presentation offers a review of the latter three groups and offers results of my recently completed study on spotted owls, great horned owls, and forest landscape patterns in the Central Oregon Cascades. Predators on spotted owls include the great horned owl, goshawk, red-tailed hawk, and common raven. Although Cooper's hawks have been observed in unsuccessful predation attempts, it seems possible that juvenile owls may be taken. Spotted owl mortality caused by avian predation is significant: a query of researchers has indicated that 40% of 91 adult/subadult and 25% of 60 juvenile radio-marked spotted owl deaths were attributable to avian predation; an additional 25% of adult/subadult and 37% of juvenile owls died of undetermined causes; it seems likely that avian predation was involved in at least some of these deaths, as well. The primary competitor of spotted owls is the barred owl. The barred owl outcompetes spotted